

VHF CHANNEL OCCUPANCY MEASUREMENTS OVER CORE EUROPE

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Contents



- B-VHF Project
- Interference
- Overlay Deployment Concept
- Stationary Area and VHF Availability
- VHF Occupancy Measurements
- Evaluation of Data
- Conclusions





B-VHF Project



- Being conducted under 6th EC Framework programme
- Develops a digital cellular broadband aeronautical integrated VHF communications system
- Multi-Carrier (OFDM) system, based on CDMA
 - MC concept allows for combining **non-contiguous** parts of spectrum into single broadband channel
 - Parts of a broadband channel may be **left unoccupied!**
- Intended to be deployed as an overlay system in VHF COM band (118 – 137 MHz)
 - Initially providing (moderate-) **additional** capacity **at “no cost”**
 - Providing full capacity after transition phase (existing VHF system would be phased out/converted to B-VHF system)

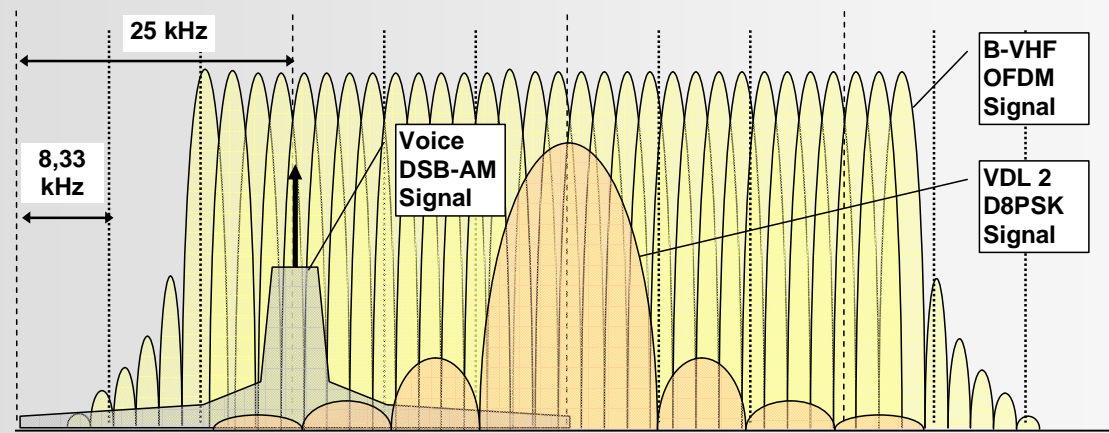




Interference



- Interference depends on spectral masks, signal powers, relative position of broadband OFDM and NB spectra AND complex **detailed mechanisms** in a victim receiver
- B-VHF investigations are based on comparison of signal powers received within **25 kHz bandwidth**, without differentiating between signal types
- Only “close” transmitters cause interference!

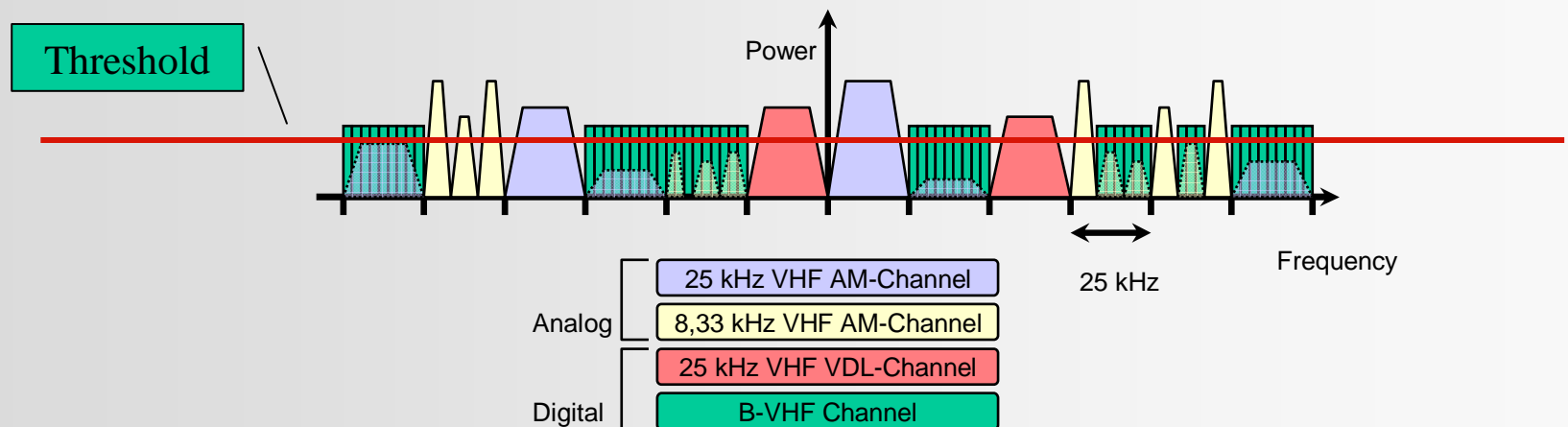




Overlay Deployment Concept



- Re-using selected VHF narrowband (NB) channels without mutual interference
 - Identify and re-use NB channels where received signal power remains below some threshold
 - B-VHF receivers **can receive** B-VHF signal in these gaps (with tolerable temporary interference or no interference at all)
 - B-VHF transmitter **can transmit** B-VHF signal in these gaps (using reduced transmitter power density than NB transmitters)





Stationary Area and VHF Availability



- Investigating the feasibility of the overlay deployment concept is an important goal of the B-VHF project!
- Different OFDM carrier sets are used in different areas
 - Allocated resources must remain “available” over entire area
- VHF spectrum availability (in B-VHF project):
 - Defined as **percentage** of all 761 VHF 25 kHz allocations where received NB signal powers (25 kHz bandwidth) remain below a given threshold within entire “stationary area”
 - Assessed for a **range** of hypothetical thresholds (-90 dBm ... -70 dBm, 2 dB steps) AND over spatial **segments** of different sizes (20 nm ... 60 nm ... 180 nm)
- Theoretical analysis AND practical measurements used for spectrum occupancy assessment

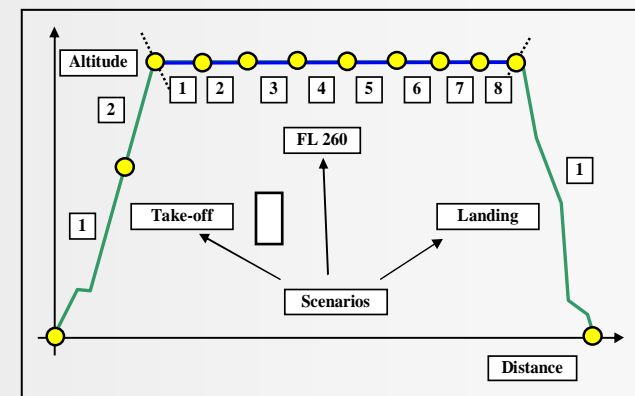
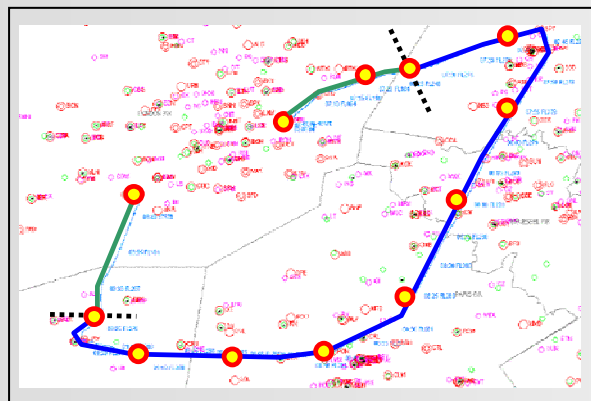




VHF Occupancy Measurements



- Dedicated flights AND ground measurements
- Representative flight: over UK, NL, BE, FR
 - Take-off, landing, cruising at different FLs, during peak hour
 - NB signal power received in 25 kHz bandwidth was recorded twice per second, independently for each of 761 VHF channels
 - Each flight (and data record) was split into segments (~60 nm)
 - System was calibrated to produce same power output as a receiver directly connected to an isotropic antenna

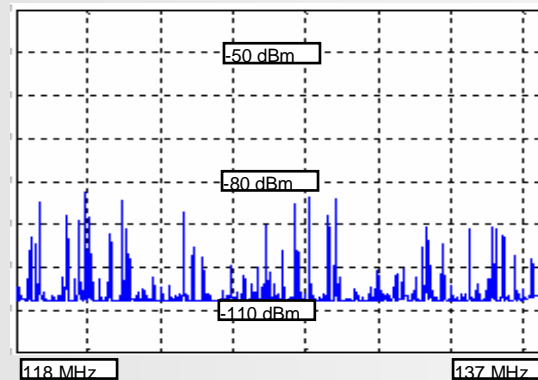




Evaluation of Data (1)



- Goal: produce VHF occupancy statistics over Core Europe, allow for an estimate of a stationary area
- Histograms of peak received power produced for each flight segment



- VHF occupancy calculated per-flight
 - Typical case (occupancy is around an average value)
 - Worst case (“local” occupancy over some trajectory segment is much higher than for the rest of the flight)

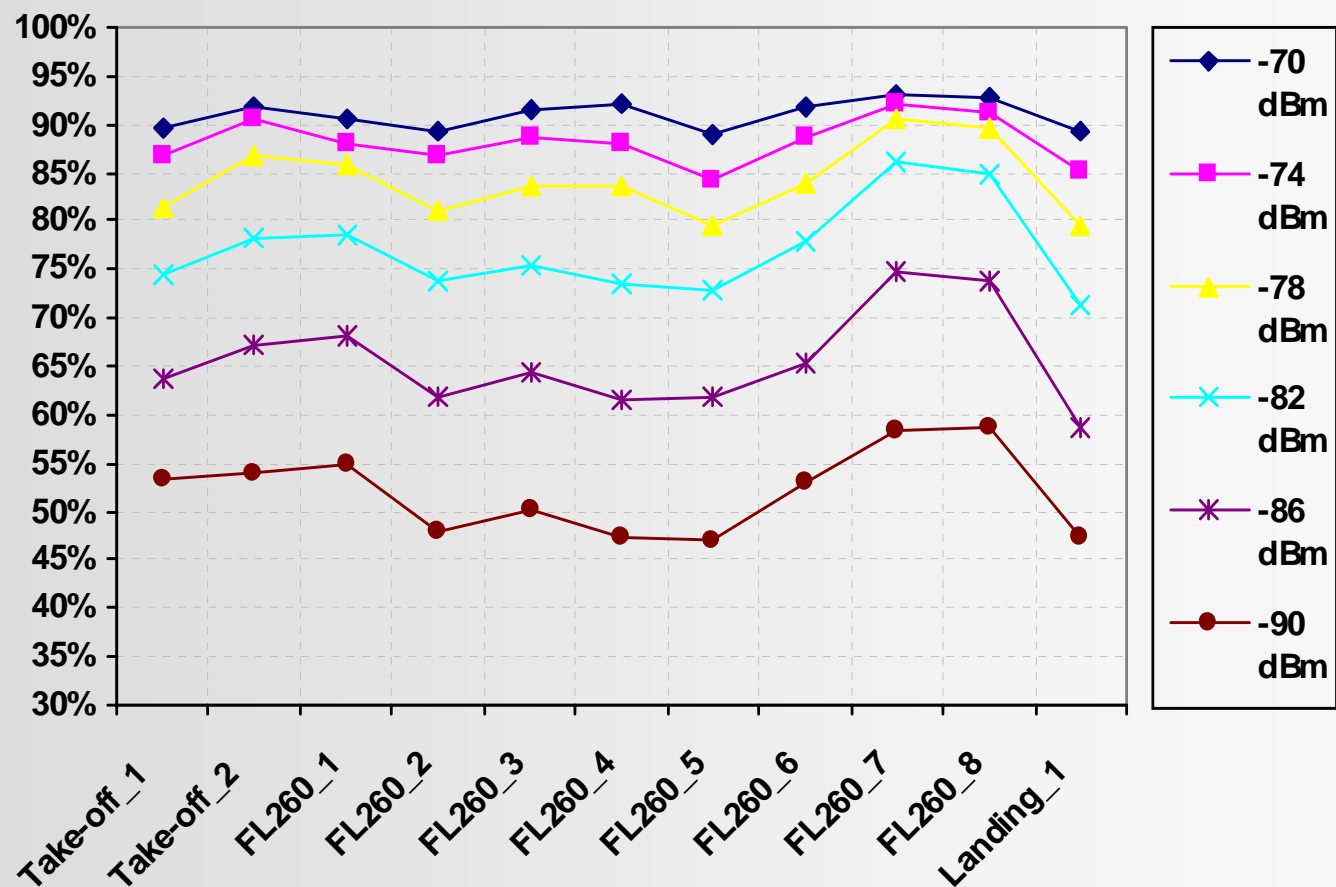




Evaluation of Data (2)



- VHF occupancy calculated per-segment, for different threshold values

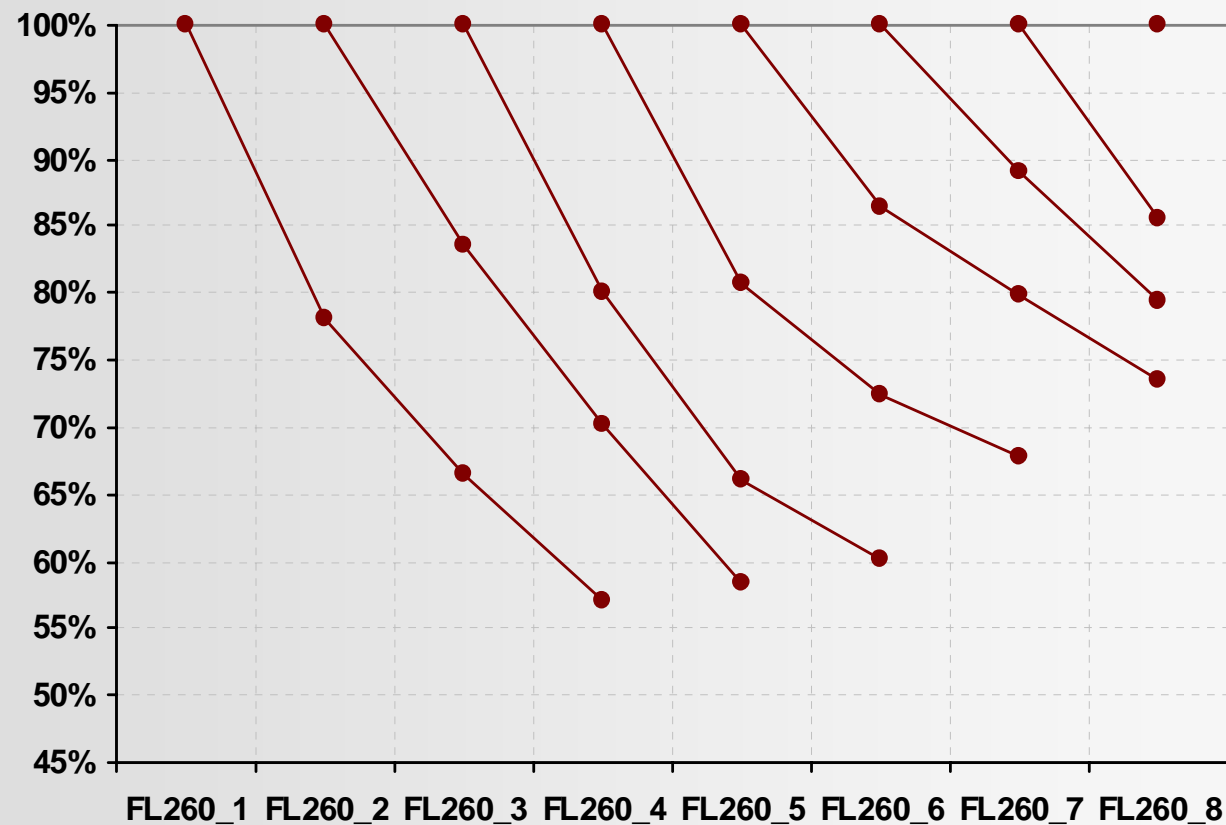




Evaluation of Data (3)



- VHF occupancy calculated over several subsequent segments (once per threshold value)

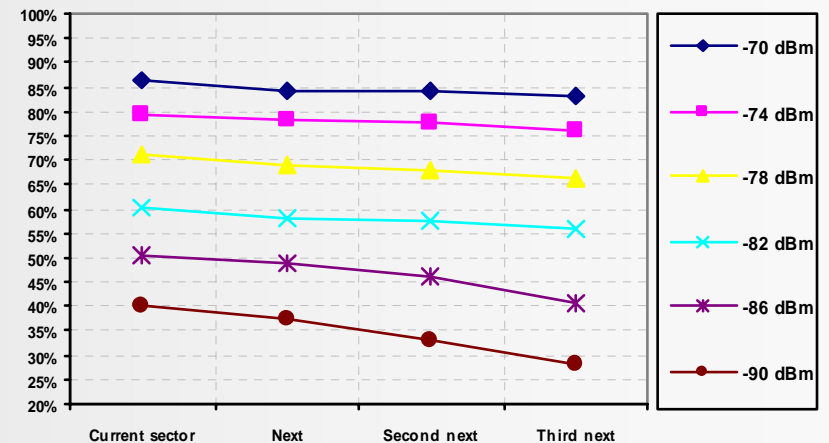
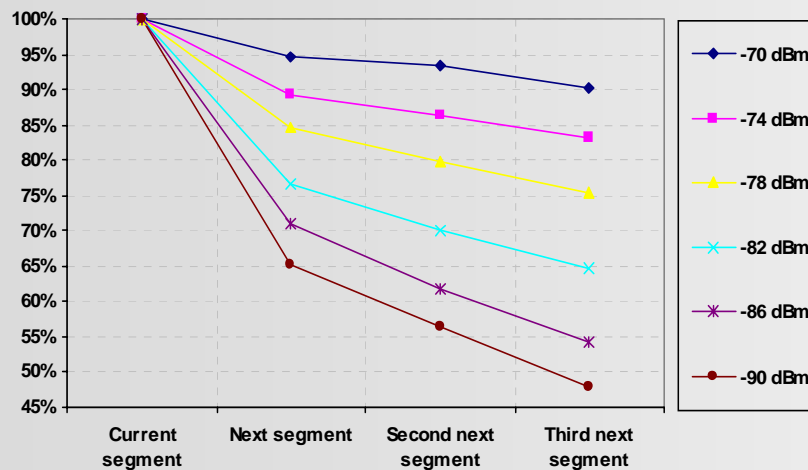




Evaluation of Data (4)



- Occupancy variation between the current segments and segments being at specified offset from the current one
- Occupancy evolution over all flights/segments of “similar” scenarios





Conclusions



- Availability decreases with increased FL (as expected)
- For the whole measurement campaign (all flights, all scenarios) measured “per-segment” availability remained above 40%
- Availability over two, three and four successive segments remained above 37%, 33% and 27%, respectively
- This is **typical**- rather than worst case
 - Not all possible interferers were captured in measured data
- There may be enough “available” VHF capacity to provide limited scope of initial B-VHF services!
- Supplementary worst case analysis is being carried out, based on the deterministic user topology

